

OUTLINES
OF A
COURSE OF LECTURES
ON
NATURAL
PHILOSOPHY.

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*Philosophia Naturalis scripta est in maximo, isto libro, quæ
continue nobis ante Oculos jacet appertus (universum hoc
ajo) sed nihil aut legi, aut intelligi poterit, nisi prius ad-
discatur idioma, quo exartum est.*

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OUTLINES, &c.

INTRODUCTION.

UTILITY of NATURAL PHILOSOPHY.
The pleasure it affords to the mind. Philosophy favorable to true religion. The Utility of its various branches pointed out ; particularly, Optics, Astronomy, Hydrostatics, Chemistry, Electricity, Magnetism, and the philosophy of living matter. Necessity of a knowledge of Natural Philosophy to those who study medicine. A view of the causes which have retarded the progress of Philosophy. Observations on Newton's rules for philosophizing. Of the nature and extent of human knowledge. Demonstration. Analogy. Of the nature of cause and effect.

SECT. I.

SECT I.

Division of the material world. Mechanical philosophy. Chemistry. Physiology.

Of matter---its properties, viz. extension and divisibility, impenetrability, inertia, attraction, motion and rest. Our ideas of impenetrability less certain than we have suspected. It is highly probable that the tangible particles of matter are not in contact, but are connected by mechanical forces, which, like gravity, act at a distance. Theory of Father Bosovich.

Attraction---of cohesion---of gravitation. Magnetic and electric attraction and repulsion. Attraction of cohesion particularly considered. Various instances of this force. Dr. Hamilton's theory of the action of capillary tubes considered;--objections to it. This force extends to a very small distance between the particles of bodies. Chemical attraction or affinity illustrated by experiments.

Of motion and its affections, viz. velocity and momentum. Laws of motion. Attraction of gravitation,---increases inversely as the square of the distance. Of the descent of bodies,---uniformly accelerated by the force of gravity. The space described by falling bodies is as the square of the time, from the beginning of the fall. The force of gravity

gravity not the same in all parts of the earth. Centrifugal force of bodies,---greatest at the equator. Gravitation not confined to the earth, but extends to the planets.

Of the mechanical powers, viz. the lever, wheel and axle, pully, inclined plane, wedge, screw. No real gain in force by mechanical contrivances, the power being only applied more conveniently; for what is gained in power is lost in time. Perpetual motion---impossible. Of the center of gravity; line of direction. Rolling bodies. The double cone and cylinder. Of pendulums; their vibration in a cycloid. Of projectiles. Theory of Gunnery, of little use for directing the practice. Observations on wheel carriages.

SECT. II.

OF ELECTRICITY.

History of Electricity. Attraction and repulsion. Spark. Of conductors and electrics. Of the electrical machine. Phænomena of electrified conductors. Positive and negative electricity. Many of those electric phenomena which are generally thought to depend on repulsion do really depend on attraction. Directions for using the electrical machine

chine. Imparted or communicated electricity. Insulation of bodies. Theory of electricity. Hypothesis of Dr. Franklin. Charged electrics. Leyden phial; accumulation of electricity in it. Electric shock. Electrical battery. The force of the shock in glass of the same thickness, proportional to the quantity of coated surface. Experiments for determining the velocity of the electric fluid--inconclusive. Nature of the electric fluid,---not the same with heat,---most probably a fluid sui generis. Drawing sparks---depends on the air being charged. Luminous points and pencils of light. Star. Though the spark appears a long extended line, yet it is probable that the electric fluid proceeds in a separate and nearly globular body. Of electrometers. Of the electrophorus; theory of it; its force recovered by itself.

EXPERIMENTS.

- 1 The electrified cork ball electrometer. 2. The animated feather. 3. Attraction and repulsion of light bodies, with the dancing figures. 4. The electrical flash, between two metallic plates. 5. Inflammable spirits and other combustible bodies fired by electricity. 6. The aurora borealis imitated. 7. The card pierced by electricity. 8. Gunpowder fired. 9. A jar discharged silently. 10. The Electric

t.ic fly 11. The electrified cotton. 12. The Electrified capillary syphon. 13. The spider, seemingly animated by electricity. 14. The illuminated tube and plate. 15. The magic picture. 16. Melted wax electrified. 17. The electrical pistol. 18. Luminous spark. 19. Electric bells.

Of electricity without evident friction--instanced in evaporation, combustion, melted sulphur, silk stockings, tourmalin.

NATURAL ELECTRICITY.

The torpedo ; its surprising properties depend upon electricity : Mr. Walsh's theory of it. Theory of thunder and lightning. Identity of lightning and electricity proved by Dr. Franklin. Sig. Volta's theory of the manner in which clouds become electrified. Of the sound produced by lightning. Sheet lightning generally inoffensive: zig-zag more dangerous: that which appears in the form of balls most so. Seeming omnipresence of lightning. Method of ascertaining the distance of thunder. Protection from the dangerous effects of lightning. Conductors---pointed and blunt. Of personal security. Many other atmospheric phenomena depend upon electricity; such as aurora borealis, shooting stars, balls of fire, ignis fatuus, water spouts, and frequently earthquakes.

MEDICAL ELECTRICITY.

Method of administering it. In what diseases to be used. Animal Electricity. Principal facts. Experiments with zinc and tinfoil.

SECT. III.

OF MAGNETISM.

The subject little known. History of the loadstone. Magnetism was thought to be confined to iron and steel, but it now appears that nickel when purified from iron, becomes more magnetic. Artificial magnets preferable to natural ones. Leading facts. 1. A magnet arranges itself in a determinate position. Poles. 2. A bar of iron which has stood a long time in a horizontal position becomes magnetic. Mariner's compass. Different degrees of magnetism discovered by experiment. The dissimilar poles of two magnets attract each other, and their similar poles repel each other. Strength of a magnet greatest at the poles,---proved by its supporting the greatest weights from thence; by an experiment with iron filings;--by the dipping needle. Course of the fluid shewn by experiments. Dip of mariner's needle. Magnetism communicated to iron. Directions for making artificial magnets. Magnetism soonest acquired and lost by soft steel; most slowly by hard. Magnetism exerted through
all

all substances except iron. Magnetic attraction and repulsion decreases as the distance increases. Reason of the dip of the needle. Variation of the compass—not constant. Variation different in different latitudes.

At London the variation before the year 1657, was east. In that year there was no variation. In the year 1665, 1 deg. 22 min. west. A. D. 1683, 4 deg. 30 min. W. A. D. 1700, 8 deg. W. A. D. 1744, 14 deg. 50 min. W. A. D. 1776, 21 deg. 47 min. W.

At Paris, before A. D. 1666, the variation was east. in that year there was none. A. D. 1670, 1 deg. 30 min. W. A. D. 1700, 8 deg. 12 min. W. A. D. 1776, 19 deg. 45 min. W.

Diurnal variation. Needle disturbed by the aurora borealis. Dr. Halley's theory of the variation of the compass. Theory of Æpinus. Walker's theory. Theory of diurnal variation. Pomiscuous experiments. Similarity of electricity and magnetism pointed out. The magnetic as well as the electric fluid prefers a shorter conductor to a longer,---proved by a curious experiment. Animal magnetism.

SECT. IV.

PNEUMATICS.

AIR.---Proofs of its materiality; of its weight; Specific gravity:---pressure arising from the weight of air, equal to near 15 pounds on a square inch. Rise of water in pumps and syphons. Toricellian experiment. Barometer:--connection between the height of the barometer and the weather. Method of determining the height of mountains. Description of the air pump. Air weighed. Pressure of the air proved by its breaking a bladder;--by the double transfer;---the Magdeburg-hemispheres;--the fountain in vacuo;--by its forcing air and mercury through the pores of wood. Common pump illustrated by a model. Resistance of air;--reason why all bodies do not fall equally quick:---a guinea and a feather, in an exhausted receiver, fall together. Mills. Cork and lead balanced.

Spring of the air equal to the pressure;--proved by a variety of experiments; particularly by its supporting a column of air, of the same height with the barometer;---by the half exhausted bladder;---the bolt head and bottle---fountain by the spring of the air;--bladder glass;---and by its being able to raise great weights.

Spring of air increased by heat;---shewn by the two glass balls connected by a tube. The air may be condensed

condensed as well as rarified. Condensing syringe. Fountain by condensed air;--plays with a number of beautiful jets. Experiments with the air gun. Analysis of atmospheric air

Chemical properties of different airs; particularly fixed air, or carbonic acid gas, oxygen gas, or dephlogisticated air; hydrogen gas. or inflammable air, &c. Nature of respiration. Effect of vegetables in purifying the atmosphere owing to their decomposing water. View of modern chemistry: its application to medicine and agriculture. Theory of the winds: Dr. Halley's unsatisfactory: that lately published by Dr. Darwin accounts very well for most of the phenomena. Undulation of the air. Sound. Musical sound. Theory of music.

SECT. V.

Hydrostatics and Hydraulics.

The pressure of fluids proved to be as their depth, without regard to its direction. The hydrostatic paradox, or the pressure of a fluid proved to be as its altitude, without any regard to its quantity. A solid immersed in a fluid loses a certain part of its weight. The theory of the hydrostatic balance, or the method of finding the specific gravity of different solids, whatever may be their form. — Hydrometer. Method of discovering the specific gravity of fluids, strength of spirits, &c. The

The principles of hydrostatics illustrated by Faux's figures. Theory of the syphon. Tantalus's cup. Intermitting springs explained. Pumps --- common, --forcing, --De la Hire's, --Taylor's, which is now used in the British navy. --- These different kinds of pumps illustrated by working models.

SECT. VI.

O P T I C S.

Nature and properties of light. Inflection. Refraction. Reflection. Ray of light. Effect of light on vegetables. Impression on the optic nerve remains some time. Medium. Density of light inversely as the square of the distance from the radiant body. Angle of incidence always equal to the angle of reflection. The sine of the angle of incidence is in a constant ratio to the sine of the angle of refraction. Different refrangibility of the rays of light. Newton's theory of colours. Theory of the rainbow. Divergent, convergent. and parallel rays. An object always appears situated in the place from whence the rays, whether refracted or reflected, seem last to diverge.

DIOPTRICS. --- Refraction through plane and spherical surfaces; --- through glasses. --- lenses, convex, concave, plano-convex, and concave, double convex and concave, meniscus. Method of finding the foci of different lenses. CATOPTRICS

CATOPTRICS.----Theory of mirrors, plane, convex and concave.

VISION.----Description of the eye : progress of the light through the eye : formation of the picture at the bottom : connection of this with vision. Seat of vision. Defects of vision. Long and short sight. Squinting.---their remedies. Single and double vision. Vision by means of glasses. Apparent magnitude. Field of vision. Brightness.

OPTICAL INSTRUMENTS.---Camera obscura. Microscopes, single and compound. Burning glasses. Telescopes ;---refracting, astronomical, day ; Dollond's. opera glass. Reflecting telescopes, Gregorian, Newtonian.

SOLAR MICROSCOPE.----Variety of small objects magnified by it ; such as farina, animalculæ in fluids, mites, the pores of wood, pith, &c.---the image of a flea, when magnified by this instrument, will generally measure ten or twelve feet. The face and spots of the sun (if any) exhibited. The circulation of blood in small animals ; and the crystallization of salts shewn.

The nature of vision is illustrated by a beautiful artificial eye, exactly resembling the natural one ; and by models of long, short, and good sighted eyes.

The

The nature of telescopes, microscopes, &c, is shewn by models in which the rays of light are represented by silk strings; by which means this branch of science is rendered perfectly plain to those who have not so much as thought on the subject.

SECT VII.

ASTRONOMY.

Antiquity of this science: its utility:--inspires us with the most sublime ideas of the creator.

Spherical figure of the earth proved from the voyages of the celebrated circumnavigators, Sir Francis Drake, Lord Anson, and Captain Cook; from the appearance of distant objects at sea; from the shadow of the earth, during an eclipse of the moon.

The earth's roundness no more affected by the largest mountains, than the roundness of a common globe by the dust thrown upon it..

SOLAR SYSTEM.---The sun is a large body, placed in the midst of an immense space, having seven planets moving round him, viz. Mercury, Venus, the Earth, Mars, Jupiter, Saturn, and the Georgium-Sidus, or Herschell:---explained by means of the globes, orrery, &c.

A Table

A Table of the solar system.

NAMES OF THE PLANETS	Distance from the Sun, in Miles.	Diameter IN Miles.	Time of Revolution		Diurnal Rotation.		Number OF Moons.
			D.	H. M.	H.	M.	
MERCURY	31,671,900	2782	87,23,15 $\frac{1}{2}$		unknown		
VENUS	49,181,700	6637	224,16,		23,32		
EARTH	81,818,400	6975 $\frac{1}{2}$	365, 6, 9 $\frac{1}{4}$		23,56		1
MARS	124,666,000	3617	686,23,		24,39		
JUPITER	425,536,000	76982	4332,8,		9, 56		4
SATURN	780,395,100	68238	10761,14		unknown		7
GEO. SIDUS	1,557,350,000	30130	30445,18		unknown		2

The diameter of the sun is 763,000 miles,
and that of the moon 1214 miles.

No such thing as absolute up and down ; but only relatively so. Gravity attracts bodies in lines tending to the center of the earth. Towards the center of the Earth we therefore call downwards, and from it, upwards, in every part of the world. The orbits of the planets are not all in the same plane. Nodes: not circular but elliptical, having the sun in one focus. secondary planets, Moons, or Satellities: Saturn's ring: the planets are all opaque bodies, shining by the light of the sun which they reflect. Proofs that the different planets move round the sun.

Annual and diurnal rotation ; how ascertained. Comets. Change of seasons accounted for, and illustrated by Ferguson's paradox. The globes and orrery Phases of the moon. Harvest moon. Eclipses. Velocity of light. Causes of the planetary motions. Of the fixed stars. Conjectures concerning a plurality of Worlds. Method of solving problems on the globes. Improved globe and quadrant. The motions of the planets round the sun, and those of the secondary planets round their respective primaries ; the eclipses of the planets and their satellities: the phases and telescopic appearances of the moon ; and a variety of celestial phenomena exhibited on the lucernal, or portable Eidouranion, which is the nearest approach to the magnificent simplicity of nature that ever was imagined.